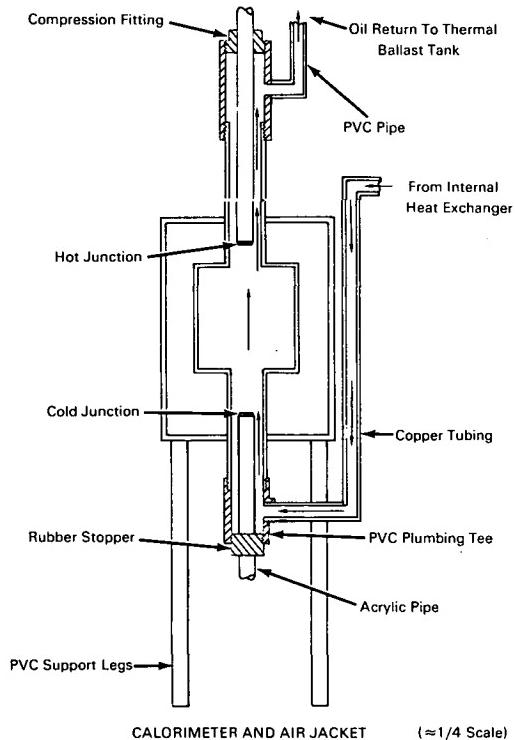


NASA TECH BRIEF



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Improved Calorimeter Provides Accurate Thermal Measurements of Space Batteries



The problem:

To design and construct a highly accurate calorimeter for measuring the thermal characteristics of space batteries undergoing typical orbital cycling. Over 200 existing designs were analyzed, but none were particularly suited for the desired measurement.

The solution:

An isothermal continuous flow calorimeter was developed and calibrated from 0.10 to 1.00 watt, the

thermal output range characteristic of nickel-cadmium space batteries. The thermal response was found to be linear in this range and the instrument was sensitive to 0.01 watt. This is 28 times as sensitive as calorimeters previously used. Temperature changes of 0.00096°C are detectable.

How it's done:

The improved continuous flow calorimeter was constructed of available components but incorporated the

(continued overleaf)

following modifications:

- (a) The direction of liquid flow through the calorimeter is reversed. The oil enters at the bottom of the calorimeter where it is sensed by the cold junction of the thermopile. It then passes over the heat generating source and exits at the top of the calorimeter where the hot junction thermopile is positioned.
- (b) The number of copper-constantan couples in the thermopile is increased from 20 to 25, increasing its sensitivity and allowing for detection of a 0.00096°C temperature difference.
- (c) The junctions of the thermopile are positioned in the center of the flow stream in a 0.75 inch diameter adjustable acrylic pipe.
- (d) The internal diameter of the exit pipe at the top of the calorimeter is reduced from 2 inches to 1.5 inches, making it the same size as the entrance pipe at the bottom of the calorimeter.
- (e) A special Lucite fixture holds the battery and calibration heater in exact position in the calorimeter.
- (f) Cast iron pipes were replaced by polyvinyl chloride pipes to eliminate any byproducts of corrosion.
- (g) The sensitivity of measurement was increased by using a lightweight hydrocarbon oil with a heat capacity lower than water.

The calorimeter is large enough that the heat generating device and calibration heater do not impede liquid flow or contact the walls, yet it is small enough to maintain essentially isothermal conditions. The calorimeter is fabricated from 316 stainless steel in the form of a right circular cylinder with a volume of 107.3 cubic inches.

Note:

Additional details are contained in *Research into Fundamental Phenomena Associated with Spacecraft Electrochemical Devices—Calorimetry of Nickel-Cadmium Cells*, by W. H. Webster and R. T. Foley, The American University, Washington, D.C. 20016. Copies of this report are available from:

Technology Utilization Officer
Goddard Space Flight Center
Greenbelt, Maryland 20771
Reference: B67-10615

Patent status:

No patent action is contemplated by NASA.

Source: W. H. Webster and R. T. Foley
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